

Service Practices 35

RADIO-TELEVISION ELECTRONICS COURSE

for home study

HOW TO CHECK FADES
AND INTERMITTENTS



RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION OF AMERICA

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HOW TO CHECK FADES AND INTERMITTENTS

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INTRODUCTION

Troubles that come and go are called *intermittents*. The receivers affected stop operating normally, and hum, distort, play low, or function improperly in other ways for a period of time; then they suddenly revert to normal operation. When the intermittent condition involves a *gradual* loss or restoration of volume, it is called *fading*.

Intermittent troubles are often the hardest ones to locate. The basic difficulty is that when you are ready to service the set, there may be no symptoms of trouble. If there are symptoms, they may not remain long enough for troubleshooting to be completed.

Intermittent trouble may be caused by a defect in the weld that joins a tube electrode and the internal wire leading to its associated tube prong. Or else the contact between the wire and the tube prong may become poor and cause intermittent trouble.

Vibration may cause a temporary short-circuit between closely-spaced electrodes in a tube, resulting in abnormal reception or no reception during the time the short persists. A defect in the tube is, of course, responsible for the too-narrow spacing between electrodes.

The pigtails of a paper capacitor — less frequently, of a mica capacitor — may break off from the body of the capacitor, producing a make-and-break contact that results in intermittently abnormal receiver operation.

Coils, particularly those through which a substantial amount of d-c current flows, may develop an intermittent high-resistance in a winding. Corrosion in the coil is likely to produce such a condition. A bad connection at a coil terminal may make and break,

causing reception to start and stop, or be weak at times.

A resistor may open-circuit because vibration has temporarily interrupted a poor pigtail connection. A poorly-soldered connection between a wire and a terminal post or socket pin may be jarred open when someone walks across the room. An antenna or lead-in connection may be defective, causing intermittently poor reception, particularly on a windy day. An improper contact between tube prongs and socket pins may introduce intermittently faulty reception. In short, a defect in practically any component in the receiver or the antenna system may be the source of intermittently abnormal performance. Trouble external to the receiver and its antenna may also be responsible for such symptoms.

The first step in servicing an intermittent receiver is to get as much information as possible about the symptoms present when the trouble is in its active phase. Troubleshooting can be considerably narrowed in scope if you get the following detailed information from the customer:

1. How long does it take (from the time the set is turned on) for the trouble to show up?
2. Does the trouble occur only during a certain interval of the day? Does it develop mostly at night?
3. Exactly what do you hear (hum, reduced volume, distortion, etc.) when the set starts working abnormally?
4. If the complaint is a reduction in volume, does the decrease occur gradually or abruptly?

5. Are the symptoms of trouble introduced or eliminated when a person walks across the room?

Any other information obtainable may also prove helpful in localizing the source of trouble quickly.

35-1. EXTERNALLY CAUSED INTERMITTENTS

Some intermittent troubles — notably changes in volume — may be due, at least in part, to troubles external to the receiver and its antenna system. It is important that you be able to quickly recognize when symptoms have such an external source to avoid wasting time looking for trouble in the wrong place.

Propagation Trouble. In areas located 30 to 100 miles from station transmitters, fading on some stations is normal. The fading is the result of a reduction in the strength of the signal during its journey from transmitter to receiver, due to the combination of ground and sky radio waves that are out of phase with each other.

Fading of this kind is worse at night than in the daytime. Stations at the high-frequency end of the broadcast band are generally affected to a greater extent than stations near the low end. Distortion may also be a symptom of this kind of trouble.

The condition just described is easy to identify; simply check reception on another set operating in the area. If the same kind of selective fading or distortion (that is, fading or distortion on certain stations) are noted in both sets, propagation trouble is most likely to blame. Installation of a directional antenna will minimize such trouble; the space required for such an antenna at broadcast frequencies, however — as well as the expense of building and installing it — make this solution impractical.

Changes in Volume Due to Line Voltage Fluctuations. When a power line is heavily loaded down by the connection of appliances or machinery that consume many watts of power, the line voltage falls considerably.

Radios connected to the line may suffer a loss in volume at such times. When the appliances or machines are turned off, receiver volume will rise (if it has previously fallen as a result of the line voltage decrease). Expect such trouble when the radio is being operated in a building where heavy machinery goes into use from time to time. If the rectifier in the set has aged appreciably, the changes in receiver volume will be more noticeable.

Generally, more than one receiver in the area will be affected by such trouble, making it likely that the source will be readily apparent. If in doubt, measure the line voltage before and after set volume has dropped; if there is a difference of 10 volts or more, the voltage fluctuations in the line are promoting, if not causing, the volume changes. Putting in a new rectifier may minimize symptoms.

35-2. INTERMITTENTS IN ANTENNA AND GROUND SYSTEM

Defects in the antenna-ground system — in the case of sets using an external antenna and ground — may be responsible for intermittent losses in volume. Troubles of this kind may also cause intermittent (or continuous) noise. To determine whether the antenna system is the source of the trouble, disconnect the lead-in from the external antenna, and connect a hank of antenna wire to the set. Throw the end of the wire out of the window, if signal pickup when the wire is stretched out along the floor is not adequate. Operate the receiver for a period of time long enough for the intermittent condition to show up. If fading and/or intermittent noise no longer develop, the antenna system is the source of the symptoms.

A similar check may be made with respect to the ground wire. An imperfect ground connection may produce fading, particularly when an external antenna is not used.

If a fading condition does not recur with the external ground wire removed, remake the ground connection, or use another and better means of grounding the set to earth.

Possible Sources of Intermittent Trouble in Antenna System. If the antenna test indicates that there is a fault in the antenna system, look for one of the following troubles:

1. Accumulation of dirt on antenna insulators or the lightning arrester.

2. Loose antenna that swings in the wind. If the antenna strikes a surface that is at earth ground potential during its swing, the strength of the signal picked up will fluctuate.

3. Break or poor connection in the lead-in. The insulated metal strip by means of which the line is brought through the window is particularly likely to develop a poor connection.

4. Poor connection between lead-in and antenna.

Inspection will reveal most of these troubles. If you suspect a break in the lead-in, substitute another piece of wire in its place and note the results. Clean dirty insulators and lightning arresters and tighten up the antenna, if it is loose, by drawing it more tautly to one of its supports and re-fastening it.

35-3. RECEIVER INTERMITTENTS THAT ARE EASILY LOCALIZED

Some intermittent defects are more easily localized than others. If you know the proper tests, it should take you no longer to track down the source of such intermittents than to troubleshoot a receiver fault that produces continuous symptoms.

Intermittents in Heater Circuits. A common source of intermittent operation in a-c/d-c sets is a defective tube heater. The heater may open-circuit when hot; when it has cooled down, the contraction of the open heater wires may bring the wires together again, completing the circuit and restoring receiver operation to normal. Look for trouble of this kind when radio reception dies down and returns to normal gradually rather than instantaneously. The relatively

slow discharge of the filter capacitors and even slower cooling of the tube cathodes permit the set to operate for a short interval after the opening of the defective heater has interrupted the series-heater circuit.

When receiver contains a tube with a heater that makes-and-breaks, the following symptoms will generally be present.

1. The pilot light will go out when the heater open-circuits; it will light up again when the heater closes.

2. If one or more of the tubes is a glass-type tube, you will be able to see the glow of the heaters die out when the heater circuit is interrupted; the heaters in the glass tubes will light again when the open heater contacts close.

Locating a Make-and-Break Heater. A tube with a make-and-break heater that is part of a series-heater string in an a-c/d-c set may be located in one of several ways. One method involves removing the chassis from its cabinet and placing it on the work bench, bottom side up. Apply power to the set. Place an a-c voltmeter near the receiver, ready for use. When the set fades, *quickly* check the voltage across each heater. We say *quickly* because the open heater may heal itself before the tests are completed; the faster the tests are made, the less chance there is of this happening.

When the a-c voltmeter is placed across a normal heater, the voltage read will be zero when the set has become inoperative, since no current is flowing through the heaters (Fig. 35-1). When the a-c voltmeter is placed across an open heater, on the other hand, the input resistance of the meter will complete the heater circuit, and current will flow through the heaters (Fig. 35-2). The line voltage will be distributed across the resistance of the heaters and the voltmeter. Since the total resistance of the heaters is very small compared with the relatively high input resistance of the a-c voltmeter, most — practically all of the line voltage, in fact — will appear across the voltmeter.

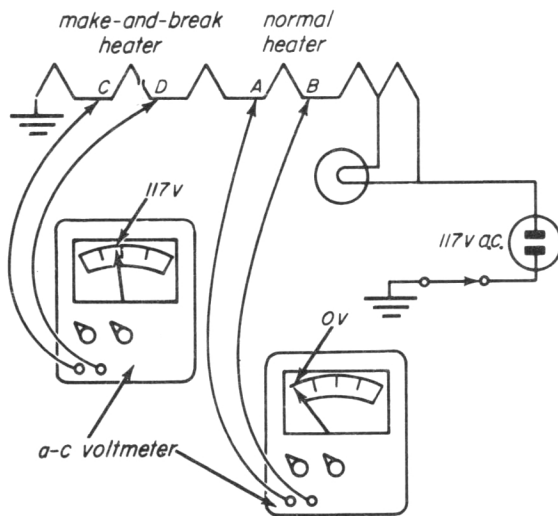


Fig. 35-1

If line voltage is read on the a-c voltmeter when the voltmeter is connected across a particular heater, the heater being measured is open-circuited.

If the reading of the meter fluctuates between the normal heater voltage and the line voltage, the heater being checked is opening and closing.

Sometimes, an intermittent heater performs abnormally for so short a time that conventional voltage tests cannot be made quickly enough to locate the faulty tube. Troubleshooting in such cases may occupy a long period of time, unless speedier detection methods are employed. A fast way of checking for an intermittently-opening heater in these circumstances is to connect a neon bulb across each heater (Fig. 35-3). by means of alligator clips. The alligator clips are attached to the prods of the neon tubes. If a heater open-circuits, the neon bulb across it will light up.

Make-and-break heater troubles occur chiefly in high-voltage heater tubes — that

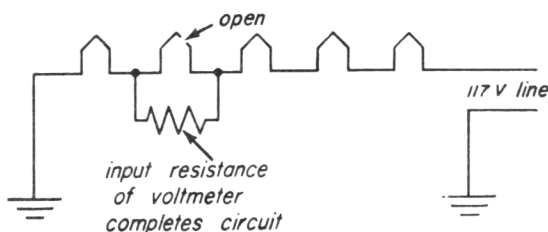


Fig. 35-2

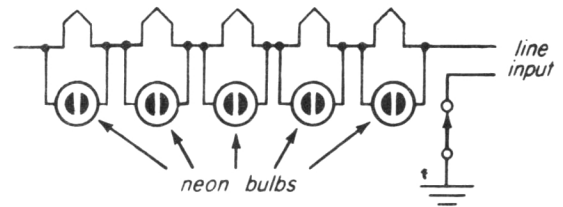


Fig. 35-3

is, tubes used in a-c/d-c sets. The problem is not a frequent one in straight a-c sets. In an a-c set, the heater of the defective tube will not light up when a break in it has occurred. If the tube is a glass type, you will be able to see that the heater is unlit; if the tube is metal, touching it will help you tell if the heater has opened. The metal envelope of the tube will be cold, cool, or cooler than normal (depending on how long the heater has been inoperative). Touch suspect tubes lightly and briefly, to avoid a burn.

Intermittent in Line Cord. A poor connection in a line cord or plug is often responsible for intermittent receiver operation. Suspect such trouble when the heaters of glass tubes are observed going dark when reception disappears. To determine whether the line plug is to blame, move it about. If the plug is a molded (all-enclosed) type, squeeze it as well as bend it in various directions. If the intermittent defect can be made to appear or disappear during this test, the plug connections should be improved or (in the case of a molded plug) the plug should be replaced.

To check the line cord, move it about and shake it. Hold the line down at various points, to better permit short sections of it to be moved around, as indicated in Fig. 35-4. If the intermittent defect can be introduced

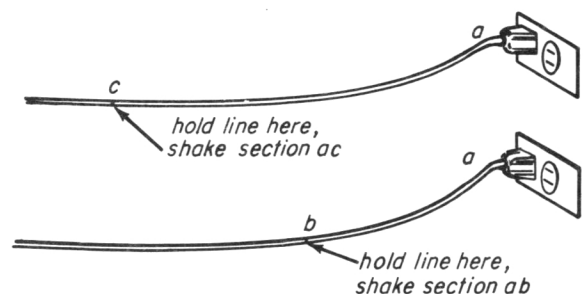


Fig. 35-4

or eliminated by this procedure, replace the line cord and retest the set.

Intermittent Off-On Switch. An intermittent off-on switch causes heaters in glass-envelope tubes to go visibly dark at the same time that it goes off. When tubes go dark, the set becomes inoperative. In order to test for such trouble, short the switch contacts with a screwdriver. If the heaters light up, but die out again when the short is removed, the switch is defective and should be replaced.

Tuning Capacitor Trouble. Dust, dirt, or metal filings between the plates of a tuning capacitor frequently cause intermittent reception. Dead spots in the tuning range are likely to be an associated symptom in cases of this kind. You'll hear scratchy sounds when the tuning capacitor shaft is rotated, if foreign matter between the plates of the capacitor is producing the symptoms. Cleaning the capacitor will serve as a test as well as a remedy for the trouble.

Intermittent Pushbuttons. The trimmer capacitors used in pushbutton tuning systems are often sources of intermittents. The capacitors tend to accumulate dust. The dust or dirt may provide a varying leakage path between trimmer plates, resulting in intermittent reception, loss of volume, or noise, on the station to which the pushbutton tunes. The source of trouble is easily located because of the characteristic noise that is heard when the pushbutton or pushbuttons affected are depressed. Clean the trimmers by depositing some carbon tetrachloride on them with an eye-dropper. Then test them by depressing the pushbuttons.

Intermittent Bandswitch. Dust or dirt on the contacts of a bandswitch may be responsible for intermittent reception, loss of volume, or noise. A characteristic noise will be heard when the bandswitch setting is changed rapidly, if bandswitch contacts are dirty. To eliminate such trouble, clean the bandswitch contacts with a suitable commercial preparation.

Dirty or Worn Volume Control. The volume control is a notorious source of inter-

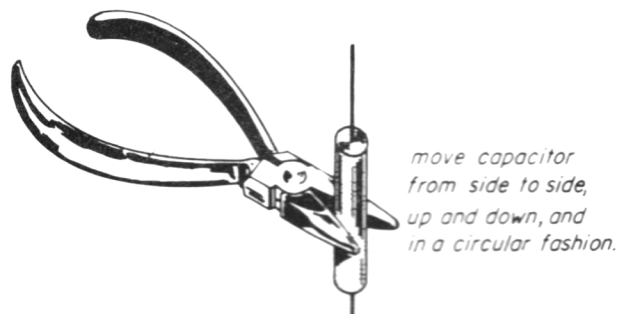


Fig. 35-5

mittent operation, hum, screeches, noise, and loss of volume. Dirt between the variable arm and the resistance element is a common cause of such symptoms. Tap the control or move its shaft quickly back and forth, to test it; if the control is dirty or worn, characteristic noises will be produced during the test. Clean or replace the control, to remedy the trouble.

Defective Bypass or Coupling Capacitors. Pigtailed may break away from the body of a bypass or coupling capacitor; intermittent trouble often results. When the capacitor is connected between the plate or screen grid of a tube and ground, arcing may take place at the site of the break. Such arcing is capable of temporarily remaking the bad connection and restoring the receiver to normal operation. When the connection cools, it is liable to open-circuit once more.

If the unit affected is an audio-stage coupling capacitor, intermittent losses in volume will take place. If the capacitor serves as a screen bypass in an rf or i-f stage, whistling, howling, or motorboating may become audible when the open develops. Wiggling suspect capacitors about with a pair of long-nose pliers (as shown in Fig. 35-5) is a good way to test for such defects. Tapping them is also a helpful check. If reception goes bad or the noise level increases when a suspect capacitor is tapped, and the same results cannot be duplicated by tapping or wiggling another capacitor, replace the suspect unit and note the results.

In some sets, more than one capacitor may be intermittently defective, due to the inferior construction of the capacitors used in these sets. Two or even three capacitors may produce similar symptoms when tapped.

To test for as well as remedy such a condition, substitute suitable units in place of all the capacitors that produce symptoms of trouble when tapped.

Intermittents That Can be Produced by Tapping, Jarring or Moving Components.

If the receiver stops working normally when it is jarred, or when someone walks across the room, one of the following troubles is likely to be present:

1. Intermittently shorting tube elements or loose connection in a tube.
2. Loose lead connection, loose riveted connections, or a poorly soldered joint.
3. Pigtailed of adjacent resistors or capacitors, or coil leads, are so close to each other or chassis that chassis vibrations cause rapid make-break short-circuits.
4. Poor socket contact. A tube pin may not make good contact with tube socket due to dirt or wax on the socket contact or the tube pin; or a contact spring on socket may not press against a tube prong tightly enough.
5. Worn or dirty volume control.
6. Intermittently defective resistor or capacitor.
7. Faulty trimmer in i-f can or on tuning capacitor.

When a receiver can be made to operate abnormally by jarring or tapping it, trouble-shooting is very much simplified. Therefore, if you are checking for intermittents, jar and tap the set with a light screwdriver that has a wooden handle. Hold the screwdriver by the metal blade, and tap the chassis and components with the wooden handle. Tap each tube gently; tap capacitors (particularly coupling and screen bypass capacitors); tap resistors; tap i-f transformer cans. When tapping one component alone brings on the trouble, whereas tapping other components does not, the component should be replaced, and the results noted.

If the intermittent is brought on when two or more components are tapped, the intensity

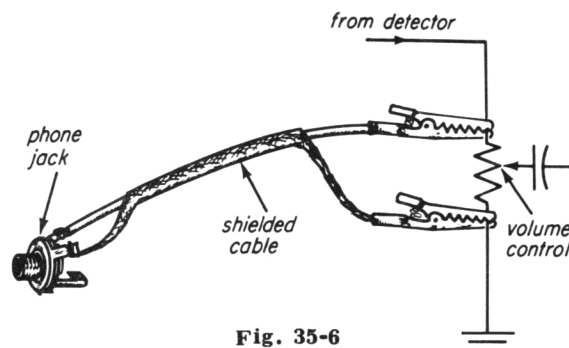


Fig. 35-6

of tapping must be reduced to the proper point. If tapping is too light, the intermittent will not occur at all; if tapping is too heavy, the vibration will be passed on from a good component, through the chassis, to the defective one, obscuring the source of the trouble.

When abnormal set operation can be brought on by tapping a number of components, but it is difficult to determine which of these parts is the actual cause of the trouble, the following tests are recommended.

In order to determine whether the trouble lies in the audio/power supply or the r-f/i-f detector sections of the receiver, connect a record player to the input of the audio section, as shown in Fig. 35-6. Operate the record player. If tapping tests still produce noise, the trouble is in the audio stages or the power supply. If you can no longer introduce noise by tapping the various components, the defective unit lies in the r-f, i-f, or detector sections.

A signal generator may be used to further localize the defect. For the audio stages, use an audio signal generator or the 400-cps audio signal that is provided at test jacks of many r-f signal generators; for the r-f, i-f and detector stages, use an r-f signal generator. In the case of an audio section fault, apply the audio signal first between grid and ground of the power amplifier. Tap the components in this stage, as well as in the power supply. If no noise is heard in conjunction with the audio tone, apply the audio signal between grid and ground of the preceding stage — commonly the first audio voltage amplifier. Now tap the components in this stage. When tapping one component consistently produces the abnormal symptom,

and tapping another component does not, the suspect unit should be replaced and the results noted.

To test the i-f and detector sections, connect the r-f signal generator between grid and ground of the i-f amplifier and feed in a modulated i-f signal whose frequency is the same as the receiver i-f. Tap the components in the i-f and detector stages, using the same test procedure as described previously.

The converter stage can be checked next. Place the signal generator cable near the antenna input terminals. If the set uses an external antenna, disconnect the external antenna first. If the set uses a built-in antenna, position the signal generator cable near the antenna. Tune the receiver off the station, and send a modulated r-f signal, whose frequency is the same as the one to which the set is tuned, through the receiver. Tap the components in the converter stage, to locate the defective unit. When an r-f amplifier is used in the set, check it at this time in the same way as the converter is checked.

In every stage, tapping tests may be supplemented by wiggling and tapping suspect components and wires. Tubes should be moved about in their sockets. Cover a tube with a handkerchief before handling it, to avoid a burn. A pair of long-nose pliers, whose jaws have been taped to insulate them, may be used for more exposed wires about. The bodies of capacitors and resistors may be manipulated with uninsulated (or insulated) long-nose pliers.

35-4. FORCING INTERMITTENTS INTO THE OPEN

If you can't make an intermittent show itself by use of the simple techniques previously described, you may have to force the intermittent into the open with the aid of one of the methods described below.

Heating Components to Make Them Go Bad. Many components have intermittent defects which appear only when the temperature of the chassis has risen above a cer-

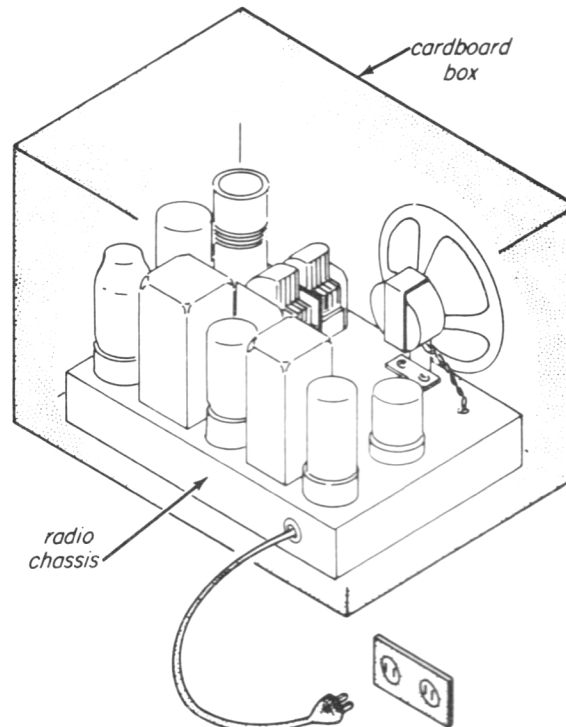


Fig. 35-7

tain level. When a radio has been taken out of its cabinet, the chassis will not heat up as much as it did in the cabinet. As a result, the intermittent defect component may not show up.

In order to simulate the heating effect of the cabinet, and yet leave the chassis readily accessible for voltage and other tests, place a cardboard box over the chassis (see Fig. 35-7). Quickly remove the box when the intermittent has appeared and make the necessary tests.

Another method of speeding up the appearance of an intermittent defect involves the use of a 300-volt bulb screwed into a reflector. Aim the light from the bulb on the parts and wiring of the set (Fig. 35-8). Take care not to heat the set up too much; paper capacitors may be damaged when the heat directed onto them is excessive. The speaker voice coil may also be warped if its temperature is raised too much. When capacitors start feeling warm to the touch, the heat treatment should be stopped.

Individual suspect parts can be heated by a hair dryer, which focuses a stream of warm air on small areas. The suspect part is tapped and moved about while it is being

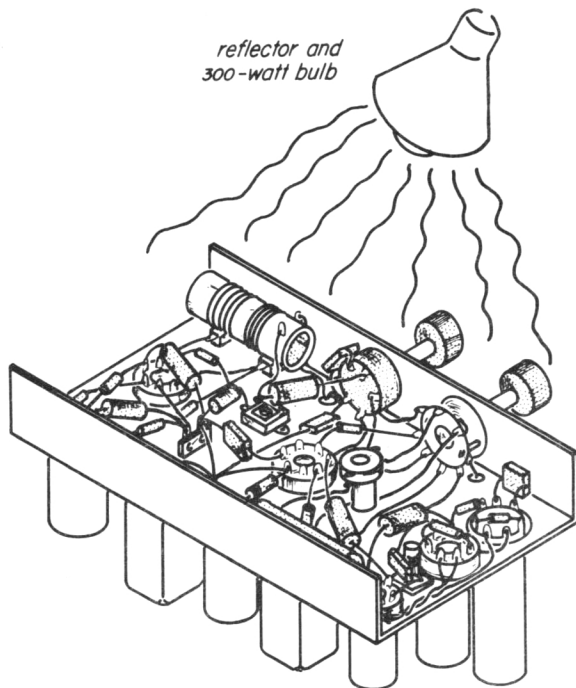


Fig. 35-8

heated, to further promote the development of any hidden defect.

Raising the Line Voltage to Find Intermittents. Some radio repairmen find it helpful to raise the line voltage from its normal value of 117 volts to as high as 130 volts to promote the speedier breakdown of an intermittent component. An adjustable line step-up transformer is used for this purpose (see Fig. 35-9). The transformer permits different values of a-c voltage to be selected and applied to the line input of the radio receiver. Transformers of this kind can be purchased from radio-parts distributors. In order to avoid damaging components that are not defective to begin with, never increase the line voltage applied to the set beyond 130 volts.

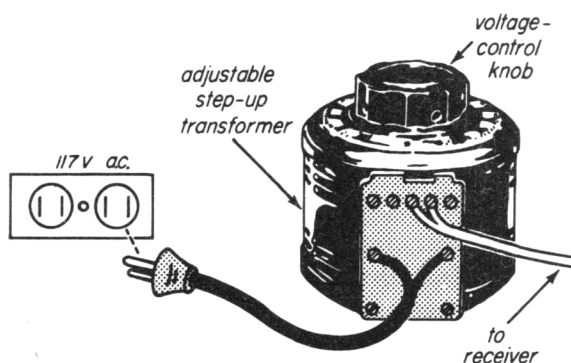


Fig. 35-9

Switching Receiver Off and On to Produce Intermittents. Some intermittent defects may be brought into the open by rapidly switching the receiver off and on several times. Others can be made active by switching the receiver off, leaving it off for a while, and then turning it on. Use both procedures when you are trying to force an intermittent defect to become active.

35-5. MONITORING TESTS

When you can't force an intermittent into its active phase, the time problem becomes important. If the trouble appears say once in eight hours, and lasts for only a few minutes, the serviceman must extract as much information as possible from the ailing set in the short interval it is performing abnormally. Otherwise, the troubleshooting job is liable to take more time than it is worth.

A technique known as *monitoring* is of great value under such circumstances. Monitoring refers to the setting up of voltmeters at various circuit points in order to help the serviceman note significant voltage changes.

Monitoring is useful in cases where the intermittent produces a considerable change in B+, AVC, or heater voltages. Defects in this category generally produce one of the following symptoms:

1. Reduced volume
2. Inoperative set
3. Distortion

Other symptoms such as hum, oscillation, and noise are often caused by component defects that produce no significant d-c voltage changes and therefore can not be detected by d-c voltage measurements.

Monitor the set when it goes dead or plays low volume at infrequent intervals. The technique requires the use of several voltmeters. If you are working in a shop, several such meters will generally be available. When three meters can be obtained, connect them as indicated in Fig. 35-10.



Fig. 35-10

If the AVC voltage has changed greatly and the other voltages are practically the same, look for trouble in the r-f/i-f and detector stages. If the B+ voltage has dropped, a tube or component in the power supply is probably defective. A shorted tube in any stage may also be responsible for a loss of B+. If the filament voltage between ground and the point monitored has changed, and the B+ voltage has not altered greatly, a cathode-to-heater short in a tube is the most probable source of the trouble. If none of the

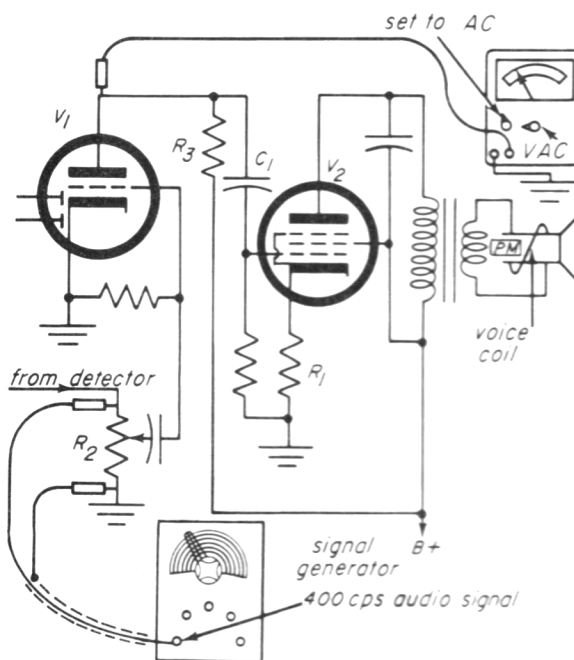


Fig. 35-11

three voltages monitored has changed greatly, look for a fault in the audio stages.

35-6. FURTHER LOCALIZATION TESTS

After the source of intermittent operation or operation at reduced volume has been localized to one of the two basic divisions of the receiver – the audio-power supply section and the section consisting of the r-f, i-f, and detector stages – further localization tests are needed. Such tests can be made only when the receiver is performing abnormally. If the techniques used to force the intermittent into the open are ineffective, you will have to occupy yourself with other service jobs until the receiver symptoms reappear. When they do, the tests described below will localize the trouble to the stage in which it originates.

Tests in Audio Stages. The test we are going to describe is recommended when the cause of intermittent operation or intermittent low volume has been localized to the audio-power supply portion of the receiver.

Shut off the receiver and remove the chassis from the cabinet. Connect the audio-signal generator to the set as shown in Fig. 35-11. Attach one a-c voltmeter lead to the plate of the audio-voltage amplifier tube;

connect the other lead to B—. Tune the receiver to the extreme low-frequency end of the dial (tuning capacitor in full mesh) so that no station will be received. Turn on the receiver and adjust the generator audio-gain control until a comfortably loud 400 cps tone is heard. Adjust the a-c voltmeter range switch to a setting where the pointer is at or near the center of the scale. This will permit any subsequent increases or decreases in the reading to be readily detected. Now leave the radio operating until the intermittent occurs, and the generator tone disappears or weakens. If the a-c voltmeter reading does not change when symptoms of trouble show up, the defect lies between the plate of the audio voltage amplifier tube and the voice coil of the loudspeaker.

If no audio tone is heard, one of the following common troubles may be to blame:

1. Defective audio power-amplifier tube (V_2).
2. Open circuit in coupling capacitor (C_1).
3. Open loudspeaker voice coil.
4. Open cathode resistor (R_1).

To locate the defect, allow the receiver and generator to remain turned on. Connect a substitute coupling capacitor across C_1 . If the 400-cps tone is heard with the substitute capacitor connected, but disappears when the capacitor is removed, C_1 is defective and should be replaced. If bridging C_1 does not eliminate the symptoms of trouble, connect a substitute cathode resistor across R_1 ; then remove this resistor. If the audio tone is heard with the substitute resistor connected, but is absent when the resistor is removed, R_1 is open and must be replaced.

The test of R_1 just described is called for (in cases of intermittent operation) only when R_1 is *not* bypassed by an electrolytic capacitor. If it *is* bypassed by such a capacitor, the set will not become completely inoperative even when R_1 open-circuits because the leakage resistance of the capacitor will complete the circuit.

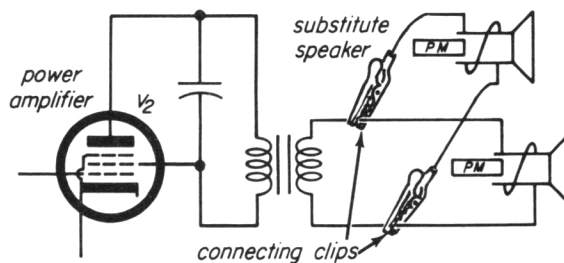


Fig. 35-12

Check the loudspeaker next, first connecting and then disconnecting a substitute speaker across the voice-coil terminals, as shown in Fig. 35-12. Next, shut the receiver off and substitute a new tube for V_2 . If the 400 cps tone is heard when the set is turned on again, the original tube (V_2) may or may not be bad. Allow the set to remain on for at least 10 or 15 minutes and see if the intermittent reappears.

Turning the receiver off to insert a substitute tube is sometimes sufficient to temporarily eliminate a defect in some other tube or component. The set may consequently play normally for a time, leading an unwary serviceman to assume that a defect in the original tube was the cause of the trouble. The defect may also be temporarily healed when one of the following operations is performed:

1. Substitute components are connected in parallel with suspect ones.
2. A light switch is snapped on or off in the room.
3. A voltage measurement is made.
4. The receiver is turned off and on.
5. The tip of a soldering iron or a screwdriver blade is touched to a component.

This is one of the most annoying features of troubleshooting intermittent defects. Don't be discouraged if you encounter such a difficulty. Here's how you can avoid being fooled by this kind of complication. Let us suppose that the receiver suddenly plays normally when a substitute capacitor is parallel with C_1 (Fig. 39-11) and continues to do so after the substitute capacitor is removed. Turn the set off, remove C_1 , and

install the substitute capacitor in its place. Now switch the set on again and note if the audio tone disappears some time later. If the audio tone does *not* disappear, allow the substitute capacitor to remain in the circuit. However, if the set stops working, remove the substitute capacitor and reinstall C_1 . Repeat the test procedure using a substitute resistor for R_1 . Do the same for all suspect parts until the intermittent one is found.

Such procedure, of course, takes time. Each substitute part must be given a tryout, with the set left on long enough for the intermittent to show itself if it is still present.

Suppose the reading of the a-c voltmeter monitoring the plate-to-ground voltage of the 1st audio amplifier remains unchanged, but the audio tone heard in the speaker becomes weaker when the set has been on for a while. (We are assuming that the symptom is intermittently weak reception.) One of the following (intermittent) defects should be looked for in this case:

1. Defective power amplifier tube.
2. Loss in capacitance of coupling capacitor, C_1 .
3. Leakage in coupling capacitor C_1 . (Look for such trouble when reception becomes distorted as well as weak intermittently.)
4. Large increase in value of cathode resistor R_1 .

Test the power amplifier tube by substituting a known good one for it. Check for a loss of capacitance in C_1 by bridging it with

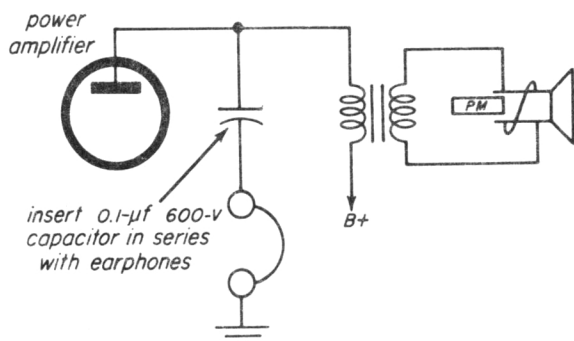


Fig. 35-13

an equivalent capacitor and noting the results. A d-c voltage test between the grid of V_2 and ground will generally reveal if C_1 has become leaky; if the d-c grid-to-ground voltage is more than 0.5 volt positive, C_1 should be disconnected, and another capacitor substituted for it. An excessive d-c voltage reading between cathode of V_2 and ground indicates a possible open in R_1 . Confirm this possibility by checking the d-c voltage between plate and cathode. It will be zero or very low if R_1 is open.

The tests just described must, of course, be made at a time when the intermittent defect is producing symptoms of trouble.

If the a-c voltmeter reading drops to zero, when an intermittently operative set stops playing, one of the following troubles is likely (refer to Fig. 35-11):

1. Defective audio voltage amplifier tube (V_1).
2. Open in plate-load resistor of V_1 (R_3).

A defect in the power supply that eliminates the B+ voltage may also be responsible for the condition just considered. Substitute suspect components and recheck the set, to determine if any of the troubles cited is present.

An intermittently shorting voice coil is sometimes the cause of intermittent operation. The a-c voltmeter reading at the plate of the first audio amplifier will remain unaffected when such trouble develops. Using a pair of earphones (see Fig. 35-13), listen in at the plate of the power amplifier. If the audio tone is audible in the phones, but not in the receiver loudspeaker, a new speaker should be substituted for the one used in the set, and results noted.

Improper contact between audio tubes and socket pins may be responsible for intermittent or intermittently weak reception. Wiggle the tubes in their sockets to check on this possible source of trouble. If the tube-to-socket connections are imperfect, the symptoms of trouble will recur during this test.

Power Supply Tests for Intermittents. If previously-described tests reveal that the B+ voltage drops considerably when the intermittent defect occurs, try the following:

Substitute a new rectifier tube. If the set uses a selenium rectifier, bridge it with an identical unit. If the intermittent defect does not reappear, the suspect unit should be replaced.

Check for other troubles in the supply, using procedures described in previous lessons, if the intermittent defect remains present long enough to permit such tests to be made. If it doesn't, substitution of suspect units, and subsequent tests of set performance, may have to be resorted to.

Checking R-F/I-F and Detector Stages.

If, with the equipment set-up indicated in Fig. 35-11, the a-c voltmeter reading remains unchanged when the receiver becomes inoperative or weakly operative, the following test should be made:

Connect one lead of the a-c voltmeter to the plate of the i-f tube, inserting a 22 k-ohm resistor in series with the lead, as shown in Fig. 35-14. The other voltmeter lead is at-

tached to B-. Turn the range switch to the 5-volt position. Connect an r-f signal generator to the grid of the converter tube. Tune the generator to the receiver's dial setting and adjust the generator r-f gain control until the a-c voltmeter indication is about 0.6 volts. Adjust the generator's audio-gain control until a 400-cps tone of a comfortable level is heard in the speaker. Wait for the set to go bad, using the tone from the speaker as the monitor. If it does not become intermittent after a reasonable length of time, try to produce the intermittent by using one of the techniques described in this lesson. In any event, when the set stops operating normally, observe the a-c voltmeter indication. If the reading is less than the original value of about 0.6 volts, the intermittent defect is between the grid of the converter tube and the plate of the i-f amplifier tube. On the other hand, if the a-c voltmeter reading remains the same, the defect is between the plate of the i-f tube and the input of the audio voltage amplifier — i.e., the detector circuit.

Intermittent in Detector Circuit. The likeliest source of trouble in this circuit (next to the tube, which was replaced in a

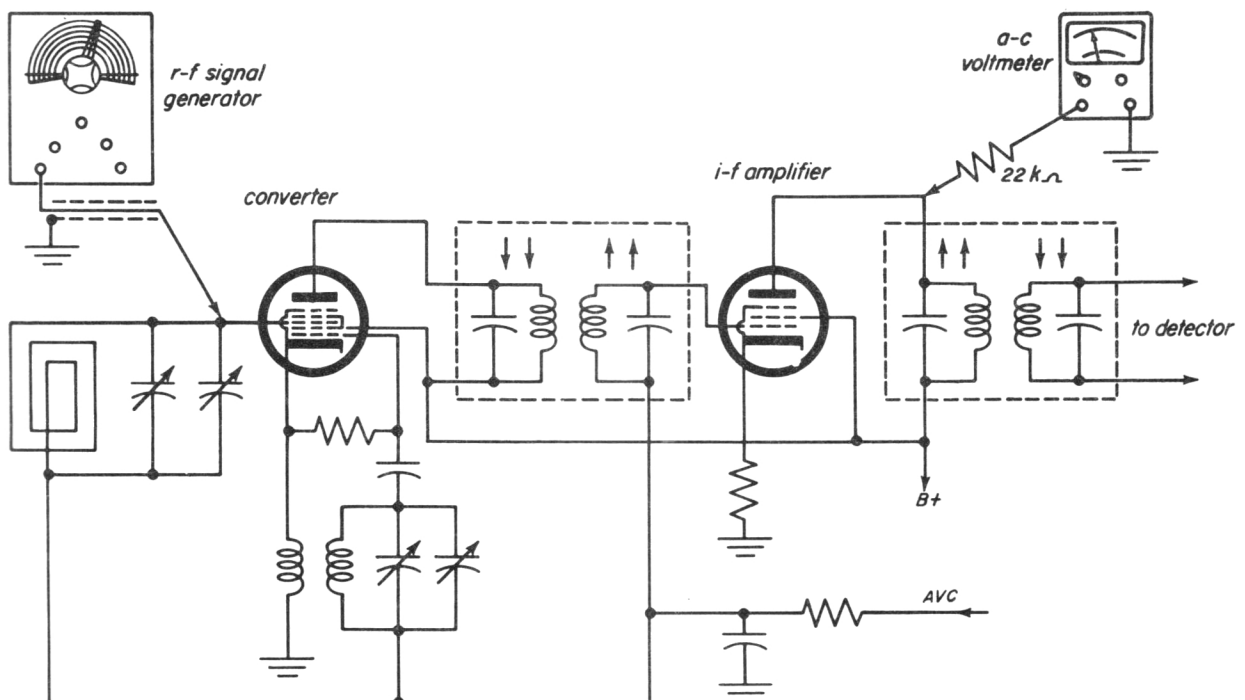


Fig. 35-14

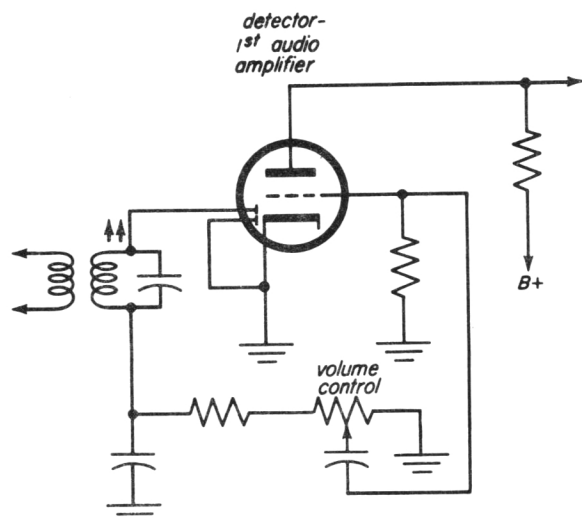


Fig. 35-15

previous test) is the volume control (see Fig. 35-15). Tap this unit from various angles; if the intermittent condition recurs during the test, the control should be replaced.

Check connections, particularly those at the terminals of the i-f coil secondary; wiggle the connections gently; tap the trimmer capacitor across the coil secondary, if one is used; try wiggling the detector tube in its socket. Substitute any suspect components and recheck circuit operation.

Location of the defective unit will be facilitated if a d-c voltmeter is connected across the volume control, while the r-f signal generator applies a modulated i-f signal to the grid of the converter. Watch the voltmeter reading while suspect parts are tapped, wiggled, and otherwise persuaded to become faulty (through the application of heat, or one of the other methods previously described). If the reading changes when one component is tapped, jarred, or heated, and does not change when other parts are given the same treatment, the component should be replaced and the results noted. In rare instances, replacement of all the components in the circuit, one at a time, with a check of set performance after each substitution, may be necessary in order to locate the defective unit.

Intermittent in I-F Amplifier. If, during the previously described test of the r-f/i-f

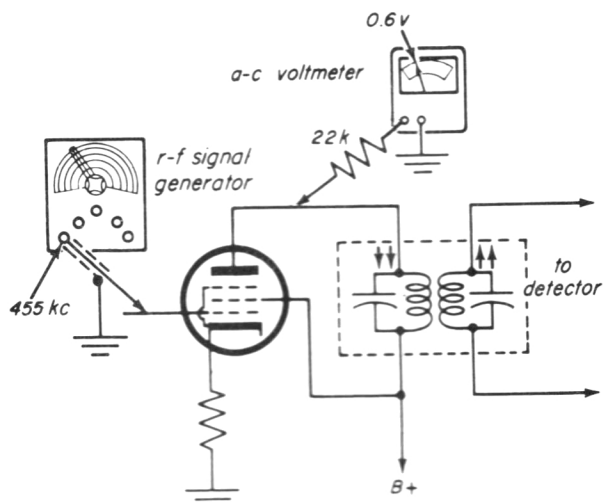


Fig. 35-16

and detector stages (refer to Fig. 35-14), the a-c voltmeter reading drops below 0.6 volt when the intermittent defect manifests itself, the defect lies between the grid of the converter and the plate of the i-f amplifier tube.

To further localize the trouble, apply a modulated i-f signal to the grid of the i-f amplifier; leave the a-c voltmeter connected to the plate (Fig. 35-16). Advance the generator output control until the voltmeter reads 0.6 volt. If the reading subsequently drops, and the audio tone heard in the speaker becomes weaker or disappears, trouble in the i-f amplifier is indicated. It is assumed that previous tests have eliminated the stages following the i-f amplifier as possible sources of the symptoms.

If the receiver starts to play normally when further tests are about to be made, apply heat to the chassis, or raise the line voltage, or use one of the other techniques previously described, to force the abnormality to reappear. When symptoms have been reintroduced, measure the plate, screen-grid, and cathode voltages of the i-f tube to be sure they are normal. If touching the d-c voltmeter lead to one of the tube elements disturbs the circuit and temporarily cures the defect, causing the set to suddenly start playing normally, proceed as follows:

Turn off the receiver, and connect the d-c voltmeter between plate and ground of the i-f amplifier. Insert a 200 k-ohm resistor in series with the hot voltmeter lead, as in-

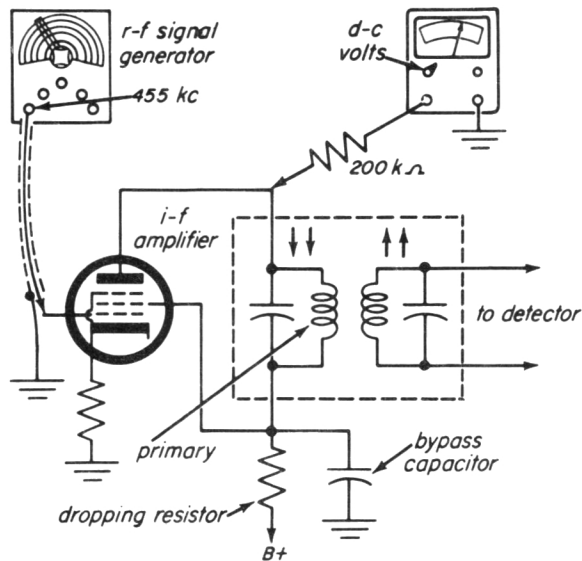


Fig. 35-17

indicated in Fig. 25-17. The resistor prevents the voltmeter from disturbing the normal operation of the i-f amplifier circuit. Set the range switch of the voltmeter to the 500-volt scale. Leave the r-f signal generator connected between grid and ground of the i-f amplifiers. Turn on the receiver and note the reading on the voltmeter. (It is assumed that the set is working normally at this time.) While the reading will not be an accurate one, due to the insertion of the 200 k-ohm resistor, it will provide a standard for comparison.

Wait for the set to become intermittent or encourage it to do so, using previously-described techniques. If the plate voltage falls to zero when the set stops working, the primary of the i-f transformer is probably open. This diagnosis is almost certainly accurate if the voltage at the bottom of the primary winding (another voltmeter can be used to measure this voltage) is normal.

When several voltmeters are available (see Fig. 35-18) plate, screen-grid, and cathode voltages may all be monitored at the same time. If the cathode voltage drops to zero but the plate and screen-grid voltages remain normal when the receiver operation becomes abnormal, the trouble is most likely an intermittent i-f tube. If the cathode voltage increases to a higher-than-normal value, the i-f cathode resistor may suddenly have increased in value. If the screen-grid

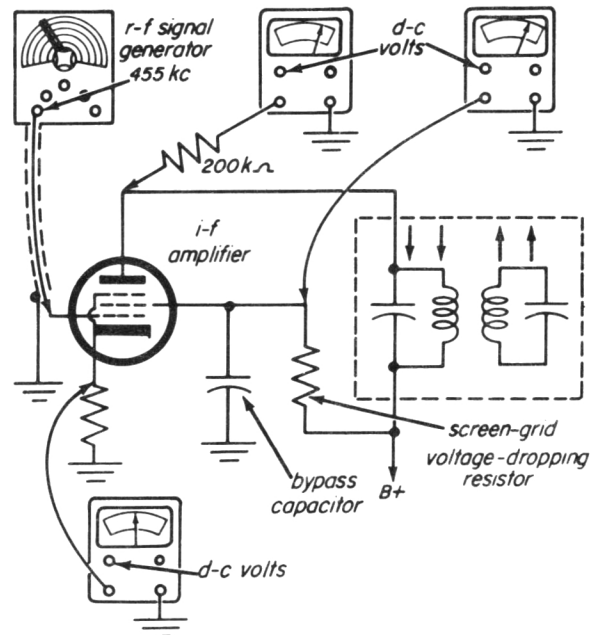


Fig. 35-18

and cathode voltage both fall to zero while the plate voltage remains abnormal, quickly check the resistance of the screen-grid voltage-dropping resistor (if one is present) for an open; also check the screen-grid bypass capacitor for a short, by measuring the resistance between screen grid and ground.

An ohmmeter check may not always indicate that a component is defective, because the unit may heal itself when it is allowed to cool off. This healing process may take place a moment or two after the set is turned off. If in doubt, substitute a new part for each suspect one in the circuit, and note results.

Checking the AVC Circuit. A component defect in the avc circuit may be the cause of an intermittent loss in volume. To check this circuit, proceed as follows:

Disconnect the i-f transformer secondary circuit from the grid of the i-f tube, as shown in Fig. 35-19. Connect the grid to B- through a 1-megohm resistor. Feed a modulated i-f signal into the i-f grid and wait for the set to lose volume. You can speed up the process by raising the line voltage, heating the circuit components, or both. If set operation no longer becomes abnormal, the fault lies in either the tuned circuit, or the section of

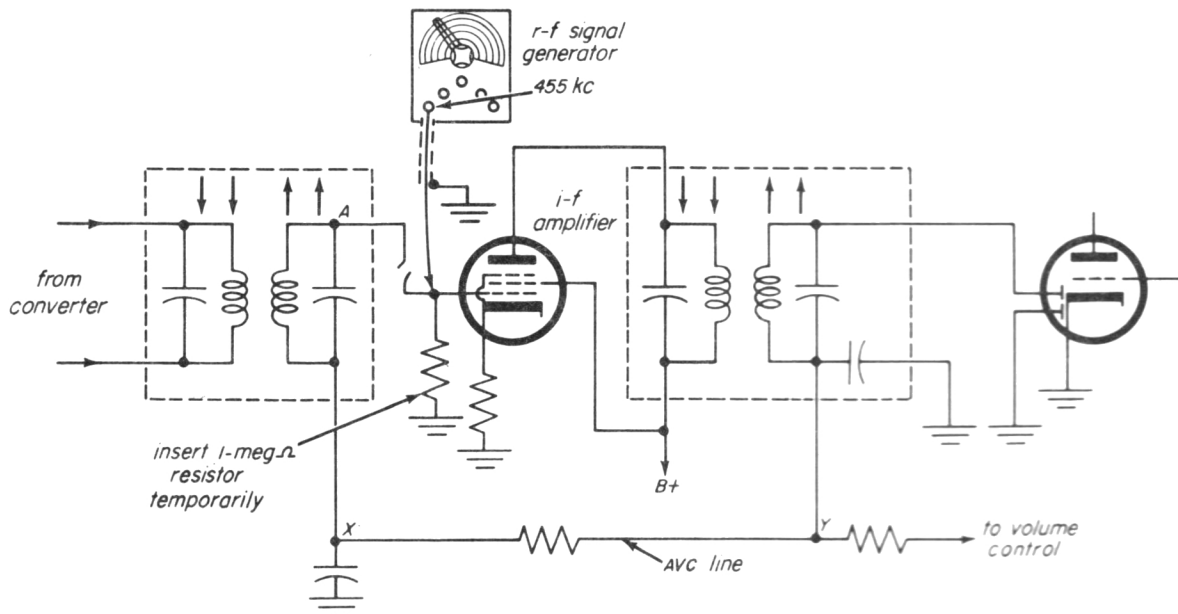


Fig. 35-19

the AVC circuit between points X and Y (Fig. 35-19).

Intermittent Defect Between Converter Grid and Grid of I-F Tube. If tests indicate no trouble in the i-f amplifier or AVC circuits, and the detector (audio) power supply circuits have been previously checked and found normal, the source of trouble is either between the grid of the converter and the grid of the i-f tube or in the oscillator section of the circuit.

Reconnect the coil lead that was previously disconnected from the i-f tube grid circuit. Connect the r-f signal generator between grid and ground of the converter tube. Tune the receiver to 1,000 kc and feed in a 1,000-kc modulated signal. Wait for the 400 cps tone to drop in volume or disappear. Use any of the methods previously described to force the intermittent into its active phase. When the set becomes intermittent, change the generator frequency setting to the receiver intermediate frequency and listen for the 400 cps tone in the speaker. If the tone is heard, it indicates that the signal is getting through the r-f section of the converter. A defect in the oscillator section is therefore likely. If neither the r-f nor the i-f modulated signal can be heard, the trouble lies between the r-f signal grid of the converter and the grid of the i-f amplifier tube.

Troubleshooting Intermittent Between Converter and I-F Tube Grids. When the receiver begins working abnormally, measure the plate and screen-grid voltages of the converter tube. If either or both of these d-c voltages are absent or low, use resistance and/or substitution tests to locate the component at fault.

If the circuit is disturbed during these voltage tests to the point where the set suddenly functions normally, turn off the receiver. Connect the d-c voltmeter between converter plate and ground. Connect another voltmeter between screen grid and ground. Turn the receiver on and wait for it to play low or stop operating. When the trouble develops, check the d-c voltmeter reading at the plate of the converter. If the plate voltage has fallen to zero, but the screen grid voltage is normal, an intermittent open in the transformer primary is indicated. An open in a resistor in series with the primary may also be the reason for a loss of plate voltage.

If the plate and screen d-c voltage readings do not change appreciably, tap and wiggle the various components in the converter circuit. Using an insulated rod, press down through the holes in the i-f can on the trimmer capacitors. If the intermittent can be produced or eliminated by the pressure of the

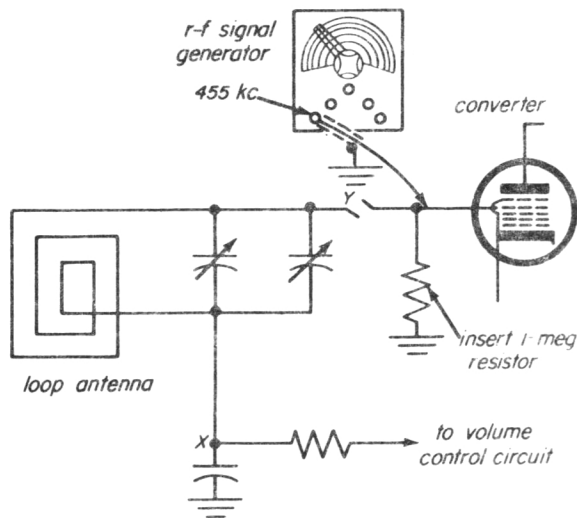


Fig. 35-20

rod against the trimmers, the trimmers or their connections are faulty.

If the tapping and wiggling tests reveal no component trouble, try a new converter tube, noting whether symptoms reappear after the substitution.

If the intermittent trouble manifests itself as a loss of volume instead of complete inoperation, the defect may be in the portion of the circuit feeding the converter tube grid. Disconnect the grid of the converter stage from the built-in antenna, as indicated in Fig. 35-20. Connect a 1-megohm resistor from the converter grid to B-. Feed a modulated i-f signal between grid and ground of the converter. Try to force the intermittent into its active phase. If the set will no longer lose volume or go dead, the portion of the circuit between points X and Y (Fig. 35-20) is at fault. To locate the defect in this portion of the circuit, use the test and substitution procedures previously described in this lesson (as well as others).

Checking an Intermittent Oscillator Circuit. When the receiver does not become intermittent with an intermediate-frequency signal applied to the converter grid, but does develop trouble when an r-f signal is injected at this point, a defect in the oscillator circuit is indicated (see Fig. 35-21).

An intermittent oscillator circuit may be checked using the methods described in this

lesson for checking intermittents in other circuits. Try to produce or eliminate symptoms of trouble with the aid of these methods: Tap and wiggle resistors; tap fixed capacitors and adjustable trimmer and padder capacitors. Replace any component if symptoms of trouble are audible when the component is manipulated or heated. Monitor the the oscillator-tube plate voltage, as shown in Fig. 35-21, to get a clue to the source of trouble.

The circuit may become disturbed when the voltmeter probe is touched to the oscillator plate, causing the set to suddenly function normally. If so, leave the voltmeter connected between the plate of the oscillator and ground and give the set another chance to become intermittent. Tune in a local station. Use heat or raise the line voltage to speed up the development of trouble. When the set stops functioning normally, observe the voltmeter reading. If the voltage is abnormally low or zero, make a thorough check of the oscillator plate-circuit components. If an oscillator coil winding is in the plate circuit, check its lead connections carefully; one of them may be imperfect. Check the resistors in the oscillator circuit that connect between the B+ line and the oscillator plate; to determine whether they are open-circuiting or changing in value. Check any bypass capacitors in the oscillator circuit that could, if leaky, reduce the plate voltage.

If the oscillator plate voltage does not change much when the set stops working

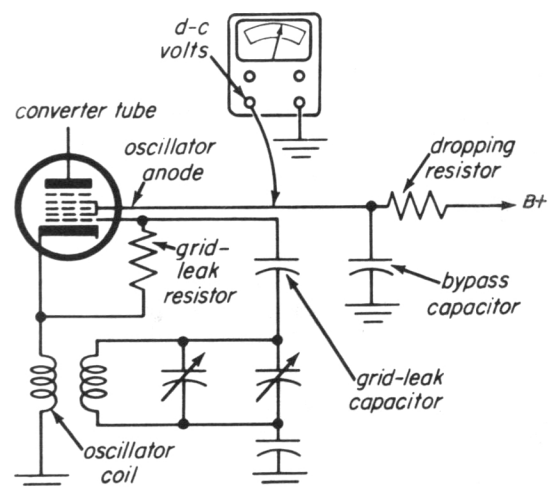


Fig. 35-21

normally, substitute a new capacitor for the oscillator grid leak capacitor (refer to Fig. 35-21). If the set continues to play normally after a prolonged test period, allow the new capacitor to remain. Do the same with the oscillator grid-leak resistor. If the oscillator coil connections look questionable, resolder them.

35-7. LOCALIZATION TESTS FOR INTERMITTENT HUM, DISTORTION, OR NOISE

In the previous section of this lesson, we described procedures useful for localizing intermittent defects that make the set inoperative or cause operation at reduced volume. Other common defects are intermittent hum, distortion, and noise. To troubleshoot such defects, first force the symptoms to occur, using one or more of the intermittent-producing methods previously described. Then troubleshoot the receiver as if the symptoms were continuous in nature, using methods you have learned in this course. The most common sources of intermittent hum, distortion, and noise are listed below.

Hum. If hum is heard when the volume control setting is minimum, check for defective filter capacitors and defective rectifier or audio tubes.

Distortion. If the symptom is intermittent distortion, check for leakage in the coupling capacitor between the first audio voltage amplifier and the power amplifier. A gassy power amplifier may also be the cause of distortion. The grid-to-ground volt-

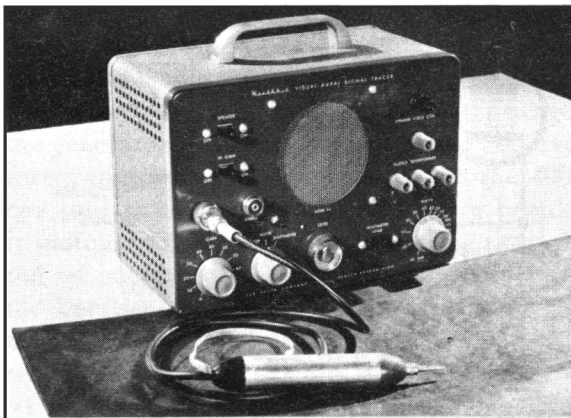


Fig. 35-22

age of the amplifier will generally be positive by more than one volt when such trouble exist. A warped voice coil that contacts the speaker pole pieces when it heats up may also be the source of an intermittent distortion.

Noise. If there is intermittent noise, look for a defective i-f transformer primary (high resistance in winding); poor connection or high resistance in an r-f or antenna coil or built-in antenna (loop or ferrite rod); dust or dirt in tuning or trimmer capacitors; defective line bypass capacitor; dirty or worn volume control; dirty band-switch contacts; tubes with loose elements; poor tube-to-socket contacts; socket pins too wide to grip tube prongs properly.

35-8. LOCALIZING INTERMITTENTS WITH SIGNAL TRACER

An instrument known as a *signal tracer* is useful for localizing all kinds of intermittent (as well as continuous) troubles. A commercial-type signal tracer is shown in Fig. 35-22. A block diagram of a representative unit is shown in Fig. 35-23. The unit has a probe that contains a diode detector. The probe is attached to a cable that feeds to the signal tracer. The signal tracer is housed in a metal cabinet, and contains a small power supply, audio amplifier, and speaker.

If the metal tip of the probe is touched to any r-f or audio circuit point in a radio receiver, the signal at this point will be conducted through the probe and cable to the amplifier and speaker of the signal tracer. By touching the probe to a circuit in a radio receiver, we can tell if a signal is present in the circuit. If a radio program signal or

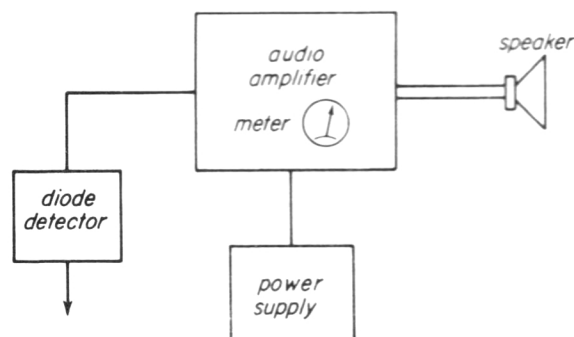


Fig. 35-23

modulated r-f signal from a signal generator is passing through the circuit, it will be heard in the loudspeaker of the signal tracer. The fidelity of the station signal may also be checked — that is, we can hear whether it is distorted, noisy, or has hum associated with it at that circuit point.

You can see that the signal tracer is basically nothing more than a simple substitute radio receiver. A meter mounted on the panel of some signal tracers allows us to *see* an indication of the signal strength, as well as *hear* the signal in the signal tracer speaker.

To locate a defect that produces intermittent operation with a signal tracer, proceed as follows. Wait for the receiver to become inoperative, or force it to go bad. Probe the input and output of each stage with the tracer, starting at the plate of the power amplifier and going successively backwards. When the signal is not heard at one circuit point, but is heard at the test point immediately preceding it, the trouble lies between the two points.

The signal tracer you are using may not provide sufficient amplification to pick up an r-f station signal at some early point in the receiver — for example, the grid of the r-f stage or the plate of the converter. To probe such points, couple the r-f signal from a signal generator to the set by placing the generator leads *near* the built-in antenna. Do not permit the position of the leads with respect to the built-in antenna to shift; otherwise undesired changes in signal level may occur. The set should be tuned to an off-station setting; the generator is set to the same frequency. The generator modulation should be *on*. Advance the generator output to the point where the tone is audible in the speaker. Note the earliest circuit point where the generator signal can be heard in the signal tracer with the receiver working normally. This is as far back as you should go in subsequent troubleshooting with the signal tracer.

To troubleshoot defects that lower receiver volume, proceed as follows: Connect the signal tracer output across the receiver

volume control. Adjust the volume control in the radio to provide normal volume. (It is assumed that the set is functioning normally at this time.) Adjust the signal-tracer gain control so that the volume of sound it produces is the same as that of the radio. Position the tracer and the radio about six feet apart, to permit the sound of one to be readily differentiated from the sound of the other. If one drops in volume and the other doesn't, you'll be able to note the change, as well as identify the unit in which it is occurring.

Either wait for the receiver to develop a loss in volume or force the defect to appear. If the tracer suffers a loss in volume at the same time that the receiver does, the defect lies in the r-f, i-f, or detector circuit; if the tracer volume remains normal—that is, the tracer plays louder than the set—the fault lies in the receiver audio stages or power supply.

When the fault has been localized to the stages ahead of the audio section, conventional troubleshooting tests may be made if the receiver continues to work abnormally. If it starts to work normally, however, connect the signal tracer between plate and ground of the i-f amplifier. Adjust the gain control of the tracer so that it plays at the same volume as the radio. Wait for the loss in receiver volume to occur, or force it to occur. If the tracer volume drops at the same time as the radio volume, the fault lies in the converter or i-f stage. If the tracer volume is higher than that of the radio, the fault is in the detector stage.

Working along in a similar fashion, the source of trouble may (if it doesn't lie in the detector stage) be localized to the i-f amplifier or converter. Connect the tracer between the plate of the converter and ground, and repeat the troubleshooting routine just described. If the tracer falls in volume at the same time as the radio, the trouble lies in the converter; if the tracer volume remains normal, the fault lies in the i-f amplifier.

If a localization test indicates that the trouble is in the audio section or power sup-

ply, connect the tracer between plate and ground of the 1st audio amplifier and follow the troubleshooting routine previously described. On the next fade, if both tracer and radio volume drop, the fault lies in the 1st audio amplifier or the power supply. If the tracer volume remains normal, the fault lies in the power amplifier or speaker. Monitoring the B+ voltage at the same time the test just described is made will determine if the power supply is the source of the intermittent.

To troubleshoot distortion, noise, or some types of hum, wait for the trouble to appear; then probe the set, starting at the voice coil, and moving backwards. When a check point

is reached where no distortion, noise, or hum exists, and trouble is present at the check point directly preceding this one, the trouble originates between these two points.

When hum, noise, reduced signal, or no signal is noted at all circuit points, look for trouble in the power supply.

Some kinds of intermittent hum and noises may be caused by troubles in an external antenna system. Some types of intermittent noise are due to the operation of electrical devices near the receiver. Troubles of this kind have been thoroughly discussed in previous booklets.



NOTES

